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Volume II of this final report consists of appendices to supplement Vol. I. The topics covered in these appendices are the Technical Steering Committee, the GPS Civil User Survey, manufacturers of GPS related products, literature search on differential GPS, and a GPS glossary of terms and acronyms.

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Global Positioning System (GPS)
Civil GPS Service (CGS)
Civil GPS Information Center (CGIC)
Operational Control Segment (OCS)
Operational, Status, and Capability (OPSCAP)
OPSCAP Reporting and Management System (ORMS)
interface control document (ICD)
differential GPS

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TABLE OF CONTENTS

PREFACE

This is the final report for work conducted by Applied Research Laboratories, The University of Texas at Austin (ARL:UT), under Contract N00024-86-C-6134, Task 12, Project 18, under the technical instruction entitled "Incorporation of the Civilian Community in GPS Operation Capability Reporting System Study". This report is in four volumes. One of the primary efforts associated with this contract was the development of an interface between the U.S. Air Force and the civil community which will allow the civil community access to information regarding the navigation status of the Global Positioning System (GPS). This interface, or point of contact, operated by a civil organization and referred to as the Civil GPS Service (CGS), will serve as a source of information from the GPS Operation Control Segment (OCS) and other sources, and disseminate that information to the civil community. The Civil GPS Information Center (CGIC) will serve as the operational arm of the CGS by providing GPS status information to the civil community.

Volume I. "Determination of the Requirements of the Civil GPS User Community," by Brent A. Renfro.

Volume I summarizes all efforts performed by ARL:UT in meeting the specific tasks described in the contract. These include

(1) establishing a steering committee,
(2) determining needs of GPS civil users,
(3) determining data and data sources which are, or will be, available to the CGS,
(4) conducting a CGS user workshop, and
(5) developing a system design for data distribution.

Volume II. "Appendices to Volume I," by Arnold J. Tucker, Brent A. Renfro, and Jeanne L. Williams.

Volume II, a compendium of appendices, addresses the results of the above tasks in greater detail.

Volume III. "Interface Control Document for the Civil GPS Service Interface to the OPSCAP Reporting and Management System," by Patrick R. Pastor.

Volume III is the interface control document (ICD) defining the requirements related to the transfer of GPS navigation data between the Operational, Status, and Capability (OPSCAP) Reporting and Management System (ORMS) and the CGS.

Volume IV. "Synopsis of Civil GPS User Workshop (22 September 1987)," edited by Arnold J. Tucker.

Volume IV is the synopsis of the GPS Civil User Workshop held on 22 September 1987 in Colorado Springs, Colorado. Included in this synopsis are transcripts of the oral presentations made during the General Session and also summaries from the various discussion groups which were chaired by members of the CGS Steering Committee.

For additional information regarding the CGS, direct queries to the following address.

DOT/RSPA
ATTN DRT-1
400 7th St., S.W.
Room 8405
Washington, D.C. 20590

INTRODUCTION

This volume contains supplemental information for the topics presented in Volume I. This report is organized as a series of appendices. Appendix A consists of the information about the Steering Committee specifically the list of members and the committee charter. Appendix B gives detailed information about the GPS Civil User Survey. Appendix C presents a matrix of information about manufacturers; this is a list of information about each manufacturer and the GPS related products available to the GPS user. A literature search was conducted for information related to differential GPS time. The results of this search are presented in Appendix D. A glossary of terms and acronyms was assembled from various sources and combined for Appendix E.

APPENDIX A

CIVIL CGS SERVICE STEERING COMMITTEE, CHARTER AND MEMBERSHIP

The steering committee for the Civil GPS Service (CGS) has two main areas of responsibility

(1) review of the system design effort for the Civil GPS Information Center (CGIC) and

(2) review of possible administrative structures by which the CGS and CGIC could be funded and controlled.

In reviewing the design of the CGIC, the steering committee shall consider the suitability of the system design with respect to definition of user requirements and methods of receiving and distributing data. It is important that the final system design be capable of dependable, responsible operation.

In reviewing possible administrative structures, the steering committee shall consider the ability of the CGS to

(1) be self-supporting to the extent possible,

(2) interact smoothly with civil GPS users and DoD, and

(3) be an advocate for civil use of GPS.

The steering committee is co-chaired by a representative of the GPS Joint Program Office and a representative of the Department of Transportation/Research and Special Programs Administration. The membership of the committee has been selected to represent the widest possible coverage of the civil GPS community.

The steering committee will meet as needed (or at least quarterly) until such time as an appropriate administrative structure for the CGIC is in place. The future of the committee beyond that point depends on the administrative structure which is developed. The date, time, and location of meetings will be determined at the preceding meeting or can be called with two weeks notice by the co-chairmen. A recording secretary will be appointed at the meetings to keep minutes and the minutes will be mailed to all members within two weeks of the meeting.

8 December 1988

* As of 23 February 1988, the Joint Program Office no longer co-chairs the CGS steering committee.

MEMBERS AND AFFILIATIONS
OF
CIVIL GPS SERVICE STEERING COMMITTEE

Name	Affiliation
Col. Gaylord Green	Joint Program Office (JPO/SD/CWN)
Capt. Mark Erkkila	Joint Program Office (JPO/SD/CWNG)
LCDR Hans Kunze	Joint Program Office (JPO/SD/CWNG)
CDR Richard Hendrickson	Joint Program Office (JPO/SD/CWN-DOT)
LTCOL E. Willert	Joint Program Office (JPO/SD/CWNI)
Lt James Hoffman	HQ Air Force Space Command/XPSS
Lt. Col. Russell Nakamura	The Pentagon (ASD/C^3I/T&TC^3)
Mr. David Allan	National Bureau of Standards (NBS)
Dr. Henry Fliegel	Aerospace Corporation
Mr. Larry Hothem	National Geodetic Survey (NGS/NOAA)
Dr. William Klepczynski	U.S. Naval Observatory (USNO)
Mr. Joe LoVecchio	Department of Transportation (DOT/TSC)
Mr. Keith McDonald	Department of Transportation (DOT/FAA)
Mr. Dave Scull	Department of Transportation (DOT/RSPA)
Dr. Randall Smith	Defense Mapping Agency Systems Center
Mr. Leonard Sugerman	Physical Science Laboratory, New Mexico State University (PSL/NMSU)
Dr. William Wooden	Defense Mapping Agency Systems Center
Dr. Arnold J. Tucker	Applied Research Laboratories, The University of Texas at Austin (ARL:UT)

ATTENDEES AT CIVIL GPS SERVICE STEERING COMMITTEE MEETINGS
18 DECEMBER 1986 - 23 FEBRUARY 1988
(NOT STEERING COMMITTEE MEMBERS)

Name	Affiliation
Pat Almazar	Air Force Space Command/XPSS
Robert Boren	Air Force Space Command/OLAJ
Alison Brown	University of Colorado at Colorado Springs (UCCS)
Ronald Bruce	Joint Program Office (JPO/SD/YEE)
Laura Charron	U.S. Naval Observatory (USNO)
James R. Clynch	Applied Research Laboratories, The University of Texas at Austin (ARL:UT
Gene Coco	Joint Program Office (JPO/SD/CWNF)
Richard Cohen	National Geodetic Survey (NGS/NOAA)
Dick Davis	National Bureau of Standards (NBS)
Christina E. Dise	U.S. Naval Observatory (USNO)
Joe Dorfler	U.S. Air Force/XOOG
Bart Ewers	ARINC Research
James L. Farrell	Westinghouse
Bill Fauver	2nd Satellite Control Squadron (2SCS)
William A. Feess	Aerospace
Charles Fosha	U.S. Coast Guard (USCG)
Adeste Fuentes	U.S. Coast Guard/Headquarters (USCGHQ)
Larry Grant	Department of Transportation (DOT/RSPA)
Chris Harvey	ARINC Research
Jim Henry	Aerospace
Robert W. Hill	Naval Surface Weapons Center (NSWC)
Jeff Johnson	Joint Program Office (JPO/SD/YEE)
Edward C. Jones	Joint Program Office (JPO/SD/CWN-NRL)
Paul Jorgensen	ARINC Research
Jeffrey Landis	ARINC Research
Jack Lang	Department of Transportation (DOT/RSPA)

Paul Massatt	Aerospace
Jules McNeff	The Pentagon (SAF/AQSS)
Roger L. Merrell	Texas State Department of Highways and Public Transportation (TSDHPT)
Mihran Miranian	U.S. Naval Observatory (USNO)
Jim Nagle	U.S. Coast Guard/Headquaters (USCGHQ)
Per Nieuwejaar	Joint Program Office (JPO/SD/YEG)
Pat Pastor	Applied Research Laboratories, The University of Texas at Austin (ARL:UT)
John Perruzzi	Defense Mapping Agency (DMA)
Pete Peters	2nd Satellite Control Squadron/ENX (2SCS/ENX)
Benjamin Remondi	National Geodetic Survey (NGS/NOAA)
Brent A. Renfro	Applied Research Laboratories, The University of Texas at Austin (ARL:UT)
Wayne N. Rhodus	Aerospace
Art Satin	Aerospace
Amer Sharma	International Business Machines (IBM)
Barry Siegel	Aerospace
R. A. Smith	Joint Program Office (JPO/SD/PMG)
Mike Sorrentino	Overlook Systems Technologies, Inc.
Donald F. Spencer	Overlook Systems Technologies, Inc.
Tom Stansell	Magnavox
William Stein	Joint Program Office (JPO/SD/YED)
Robert Stepan	SAF/AQSS
Jeanne L. Williams	Applied Research Laboratories, The University of Texas at Austin (ARL:UT)
Gernot Winkler	U.S. Naval Observatory (USNO)
3ryant Winn	Aerospace
Neville Withington	U.S. Naval Observatory (USNO)

APPENDIX B

GPS CIVIL USER SURVEY

A survey was conducted through several organizations to determine the civil GPS user requirements. The survey was conducted in order to determine the needs of the civil GPS community and if a Civil GPS Service (CGS) would be useful. The results were analyzed to determine the loading requirements on the CGS. A sample survey is included. A total of 178 responses from the GPS user community was received. The breakdown of responses between the U.S. and foreign countries was 55% U.S. and 45% foreign. This shows a wide interest and planned use of the system internationally.

The results of the survey are shown in Table II. A respondent could give more than one answer per question. So the percentages shown were derived from the total number of responses to a given question, not based on the number of respondents. The user categories were broken down into land, marine, aviation/aerospace, and others. The results have been compiled with this breakdown.

The question related to the use of CGS indicated that the service will be used heavily, with the marine community using it less, based on continued use of Notices to Mariners. The frequency of use of the CGS is on a daily or weekly basis. The respondents to the survey were predominantly ones with GPS experience. Approximately 25% of the civil users plan to use the P-code signal. This is probably a larger number of P-code users than DoD had anticipated.

The results of the survey will assist CGS in anticipation of the load, type and frequency of requests for data, and the methods to be used to transfer information.

GPS CIVIL USER SURVEY

1. With which application(s) of GPS will you be involved?

_____Navigation _____Time/Frequency
_____Surveying _____Manufacturer
_____Position Location _____Other

2. What best characterizes the type of user you are?

AVIATION/AEROSPACE
_____General Aviation
_____Commercial Aviation, Air Taxi, Helicopter, etc.
_____Aerospace
MARINE
_____Recreational Boater
_____Fisherman
_____Commercial Shipping, Passenger Vessels
_____Research Vessel
LAND
_____Trucking/Railroads
_____Automobile/BusFleets (Police, Taxi, etc.)
_____Public Safety (EMS, Firefighting Vehicles, etc.)
_____Geodetic Survey
_____Legal/Record Keeping
_____Timekeeping
OTHER (Explain)_______________________________________

3. Your requirements for assistance or for data will fall into what categories?

_____Basic Planning on GPS (e.g., System Overview)
_____Planning Information (e.g., Projected Performance)
_____Status Information
_____Archival Data (e.g., Performance History)

4. What method(s) will you use to obtain information on GPS?

_____Direct Contact _____Data Tapes or Disks
_____Voice Recording _____Publications
_____Computer Access via Modem
_____NOTAMS and/or Notices to Mariners

5. What is your current level of experience with GPS?

_____No Experience
_____Informed about GPS (Publications, Meetings)
_____Operational Experience (Receiver Operation Data Processing)

6. What is your current source of GPS status information?

_____None _____Yuma Bulletin Board
_____OCS _____Other
_____USNO Bulletin Board

Would you use the Civil GPS Service, if available?
_____Yes _____No
If yes, when does your current source become inadequate?
_____________(Month/Year)

7. Your application of GPS will be under what conditions?

_____Static
_____Low Dynamic (Vessels, Vehicles)
_____High Dynamic (Aircraft)

8. Your data needs will be mostly for

_____Realtime Data _____Postprocessed Data

9. What is the "age" of the data you will need?

_____Pre-Event _____Post-Event
_____Realtime _____1 Hour-24 Hours
_____1 Day-7 Days
_____> 7 Days

10. Which signals will you use?
_____Carrier Only
_____Code
  _____C/A Code
  _____P Code

11. What methods of application will you use?
_____Point Positioning
_____Time Transfer
_____Differential Positioning (Real)
_____Relative Positioning (Post)

12. Which type(s) of information will you require?
_____Timing
_____Satellite Operational Status
_____Orbit
_____Scheduled Events (e.g., Satellite Launches)
_____Other(s) ____________________

13. *List the specific kinds of information needed to meet* your requirements.
TIMING
_____GPS Time Steer Schedule
_____GPS-UTC Phase & Frequency Offset
_____Other(s)____________________
SATELLITE OPERATIONAL STATUS
_____SV Health
_____SV Upload Schedule
_____Other(s)____________________
ORBIT
_____SV Almanac
_____SV Orbit Adjust
_____Other(s)____________________

14. How often will you require access to the Civil GPS Service office?
_____Hourly
_____Daily
_____Weekly
_____Monthly

15. Would you be interested in this concept being expanded to include OMEGA, LORAN, and NAVSAT information?
_____Yes
_____No

16. What is your anticipated location at the time you will require assistance from the Civil GPS Service?
_____Africa
_____Antarctica
_____Arctic
_____Asia
_____Australia
_____Europe
_____North & Central America
_____South America
_____Atlantic Ocean
_____Indian Ocean
_____Pacific Ocean
_____Global

17. If you would like to receive further information on the Civil GPS Service please include your name and address with this survey.

PLEASE LIST ANY ADDITIONAL COMMENTS YOU HAVE ABOUT THE CIVIL GPS SERVICE ON A SEPARATE PAGE.

TABLE I

CGS CIVIL USER SURVEY RESULTS

	LAND 41%	MARINE 25%	AVIATION/ AEROSPACE 24%	OTHER 10%
WILL USE CGS	89%	75%	87%	86%
LEVEL OF GPS EXPERIENCE				
OPERATIONAL	74%	64%	53%	68%
INFORMED	23%	29%	37%	29%
NONE	2%	8%	10%	2%
SIGNAL TO BE USED				
C/A (CARRIER)	30%	27%	22%	30%
C/A (CODE)	48%	51%	52%	48%
P-CODE	22%	23%	26%	22%
TYPE OF INFORMATION				
TIMING	17%	16%	18%	15%
STATUS	30%	32%	33%	30%
ORBIT	24%	24%	21%	22%
SCHEDULED EVENTS	27%	28%	27%	27%
OTHER	2%	0%	1%	5%
AGE OF DATA				
PRE-EVENT	24%	27%	27%	26%
REALTIME	30%	36%	39%	35%
POST-EVENT: 1-24 h	15%	10%	9%	14%
POST-EVENT: 1-7 days	21%	18%	17%	17%
POST-EVENT: >7 days	10%	9%	8%	8%
METHOD TO OBTAIN DATA				
COMPUTER VIA MODEM	26%	24%	19%	31%
PUBLICATIONS	25%	27%	26%	26%
DIRECT CONTACT	19%	21%	21%	22%
DATA TAPES/DISKS	13%	8%	13%	10%
VOICE RECORDING	8%	7%	8%	5%
NOTAMS	8%	14%	12%	6%
FREQUENCY OF USE OF CGS				
HOURLY	1%	2%	3%	5%
DAILY	30%	34%	21%	47%
WEEKLY	55%	52%	53%	34%
MONTHLY	14%	12%	23%	13%

APPENDIX C

GPS RECEIVER MANUFACTURERS AND MATRICES

This appendix contains matrices listing manufacturers of GPS receivers. These matrices are based on a paper by Mr. Keith McDonald (Federal Aviation Administration), Dr. Brad Parkinson (Stanford University), and Carolyn P. McDonald (Navigation Technology Seminars, Inc.), entitled "A Survey of GPS User Equipment, Applications and Receiver Technology Trends." This paper was presented at The Institute of Navigation Satellite Division First Technical Meeting, at Colorado Springs, Colorado, 21-25 September 1987.

With permission of Mr. Keith McDonald, this paper was used as the basis for the matrices. Additional manufacturers have been identified and are included in this list.

GPS MANUFACTURERS

Allen Osborne Associates
756 Lakefield Road
Building J
Westlake Village, CA 91361-2624

Aero Service Division
Western Atlas International
3600 Briarpark Drive
P. O. Box 1939
Houston, TX 77251-1939

Canadian Marconi Company
Avionics Division
415 Legget Drive
Kanata, Ontario K2K 2B2
Canada

DATUM, Inc.
1363 S. State College Blvd.
Anaheim, CA 92806-5790

EDO Canada Ltd.
8-6320 11th Street, SE
Calgary, Alberta T2H 2L7
Canada

GEO/HYDRO, Inc.
2115 E. Jefferson Street
Suite 505
Rockville, MD 20852

Interstate Electronics Corp.
1001 East Ball Road
P. O. Box 3117
Anaheim, CA 92803

ISTAC, Inc.
444 N. Altadena Drive
Suite 101
Pasadena, CA 91107

Japan Radio Co.
c/o Rathon Marine
1521 S. 92nd Place
Seattle, WA 98108

Kinemetrics/Truetime
3243 Santa Rosa Avenue
Santa Rosa, CA 95407

Litton Aero Products
6101 Condor Drive
Moorpark, CA 93021-2699

Magnavox Advanced Products
and Systems Co.
2829 Maricopa Street
Torrance, CA 90503

Motorola
Government Electronics Group
Radar Products Office
2100 E. Elliot Road
P. O. Box 22050
Tempe, AZ 85282

Norstar Instruments, Ltd.
319 2nd Ave., SW
Calgary, Alberta T2P 0C5
Canada

Odetics (KODE) Inc.
1515 S. Manchester Ave.
Anaheim, CA 92802-2907

Plessey Avionics Ltd.
Martin Road, West Leigh, Havant
Hampshire P095DH
United Kingdom

Rockwell International
Collins Government Avionics
Division
400 Collins Road, NE
Cedar Rapids, IA 52406

Sperry Corporation
Aerospace and Marine Group
1070 Seminole Trail
Route 29
Charlottesville, VA 22906

Standard Elektrik Lorenz AG
Defense and Aerospace
Business Division
P. O. Box 40 07 49
Lorenzstrasse 10
D-7000 Stuttgart 40
Federal Republic of Germany

Stanford Telecommunications, Inc.
2421 Mission College Blvd.
Santa Clara, CA 95054-1298

Texas Instruments, Inc.
6600 Chase Oaks Blvd.
M/S 8449
P. O. Box 869305
Plano, TX 75086

Trimble Navigation, Ltd.
585 North Mary Avenue
P. O. Box 3642
Sunnyvale, CA 94088-3642

MANUFACTURER	MODEL	SPS,PPS/ NO. OF CHANNELS	APPLICATION / ENVIRONMENT	POWER	WEIGHT	SIZE	LIST PRICE RECEIVER
Allen Osborne Associates	TTR-5A	SPS/1	Timing / Land	110 Vac, 60 Hz 230 Vac, 50 Hz 100 V A (max)	28 #	17" x 16" x 7" (W x L x H)	$15 K
Austron, Inc.	2101	SPS/1	Timing / Land	115-230 Vac 50 - 60 Hz <100 W	* < 20 # ** < 27 #	5.25" x 17.25" x 17" (H x D x W)	
	2200	SPS/1	Timing / Land	< 100 W	30 #	10" x 5.25" x 19" (W x H x D)	
Aero Service Division of Western Atlas International	Macrometer II ®	PPS/6 Codeless	Surveying / Land	215 W 12, 24 Vdc	120 #	28" x 11.6" x 29.6" (W x H x D)	
	Mini-Mac 2816 ®	PPS/6 Codeless L2	Surveying/Navigation / Land	40 W 12 - 36 Vdc	40 #	1600 cu. in. (volume)	
	Mini-Mac 1816 ®	SPS/2	Surveying/Navigation / Land	40 W 10 - 36 Vdc	40 #	1600 cu. in. (volume)	
Canadian Marconi Company	CMA-774	PPS/2	Navigation/Timing / (Military) Land, Marine and Aeronautical	300 W	60 #	1600 cu. in. (volume)	
	CMA-786 C-Set	SPS/2	Navigation/Timing / Land, Marine and Aeronautical	50 W 28 Vdc 115 Vac	20 #	1600 cu. in. (volume)	$20 - 25 K
	MK-II (PLANNED)	PPS/2	Navigation/Timing / (Military) Land, Marine and Aeronautical				
* Receiver ** Controller							

MANUFACTURER	MODEL	SPS,PPS/ NO. OF CHANNELS	APPLICATION / ENVIRONMENT	POWER	WEIGHT	SIZE	LIST PRICE RECEIVER
Datum, Inc.	FTS 8400	SPS/1	Timing / Land	115/230 Vac 20 - 35 Vdc	60 #	7" x 28" x 29" (H x D x W)	
	9390	SPS/1	Timing/Frequency / Land	90/130 Vac 47.5 - 66 Hz 100 V A	35 # (w/o batt) 45 # (with batt)	7" x 18" x 19" (H x D x W)	
	9390-5000	SPS/1	Surving/Timing/ Frequency / Land	50 W 20 - 35 Vdc 90 - 130 47 - 66 Hz	45 # (with batt)	7" x 18" x 19" (H x D x W)	$25 K
	9390-5500	SPS/2	Navigation/Timing Frequency / Land	50 W 115/230 V 50/60 Hz	25 #	3.5" x 18" x 19" (H x D x W)	
EDO Canada Ltd.	SatTrak	SPS/4	Surveying/Navigation / Land/Marine	22 W 11 - 15 Vdc	31 #	16.2" x 11.8" x 6.7" (W x H x D)	$70 K
	JMR GeoTrak	SPS/8 (Mux. rec.)	Surveying/Navigation / Land	22 W	30 #	9" x 7" x 7" (W x H x D)	$57 K
GeoHydro	1991	SPS/1	Surveying / Land and Marine	ac / dc	4 kg	28 cm x 28 cm x 6 cm	
Interstate Electronics	Astrolabe II A-2	SPS/1	Surveying/Timing / Military: Land and Marine	110-220 Vac 19-32 Vdc	40 #	29" x 5.5" x 23" (W x H x D)	$50 K
	Astrolabe III A-3	SPS/1 or SPS/2	Navigation/Timing / Military: Land, Marine and Aeronautical	28 Vdc	10 #	150 cu. in.	
	High-Dynamics I-HD	PPS/1 or PPS/2	Navigation / Military: Land, Marine and Aeronautical	80 W 28 Vdc		5" dia. x 20" L 390 cu. in.	$100 K (est.)

MANUFACTURER	MODEL	SPS,PPS/ NO. OF CHANNELS	APPLICATION / ENVIRONMENT	POWER	WEIGHT	SIZE	LIST PRICE RECEIVER
ISTAC	2002	PPS (Codeless)	Surveying / Land	30 W 12-86 Vdc	15 #	9" x 7" x 7" (W x H x D) 440 cu. in.	$57 K
	MPS-1 (PLANNED)	PPS (Codeless Differ.)	Navigation/ Surveying / Marine				
Japan Radio Corporation	JLR-4000	SPS/1	Navigation/Timing / Land/Marine	30 W 115/230 Vac 10-40 Vdc	14 #	12.6" x 4.7" x 9.8" (W x H x D)	$25 K (est.)
Kinemetrics True Time	GPS-DC	SPS/1	Timing / Land	55 W 93-135 Vac 47-400 Hz 10-40 Vdc	23 #	17" x 3.5" x 17" (W x H x D)	$15.5 K
Litton Aero Products	LTN-700	SPS/1	Navigation / Aeronautical	150 W 115 Vac 400 Hz	20 #	12.6" x 7.5" x 7.5" (W x H x D) 730 cu. in.	$50 K
	LTN-710	SPS/1	Surveying/ Navigation / Aeronautical	40 W	11 #	470 cu. in.	
	LGSS	SPS/1	Surveying/Timing / Land	ac 115/230 Vac 50 - 400 Hz dc 20 - 35 Vdc	10 #	16" x 9" x 7.75" (L x W x H)	

MANUFACTURER	MODEL	SPS,PPS/ NO. OF CHANNELS	APPLICATION / ENVIRONMENT	POWER	WEIGHT	SIZE	LIST PRICE RECEIVER
Magnavox	MX 1102-GPS	SPS/2	Navigation / Marine	100 W 100/45/230 Vac +/1 15% 45-440 Hz 24 Vdc	75 #	16.5" x 17" x 14" (W x H x D)	$35 K
	MX 1105-GPS	SPS/2 GPS - TRANSIT and Omega	Navigation / Marine	100 W 100/45/230 Vac +/1 15% 45-440 Hz 24 Vdc	75 #	16.5" x 17" x 14" (W x H x D)	$62 K
	MX 1107-GPS	SPS/2 GPS - TRANSIT, Dual Channel	Surveying/ Navigation / Marine	100 W 100/45/230 Vac +/- 15% 45-440 Hz 24 Vdc	75 #	16.5" x 17" x 14" (W x H x D)	
	MX 1157-GPS M7	SPS/2 GPS - Omega, Dual Transit	Navigation / Marine	100 W 100/45/230 Vac +/- 15% 45-440 Hz 24 Vdc	75 #	16.5" x 17" x 14" (W x H x D)	$25 K
	MX 4400	SPS/2	Navigation / Land, Marine and Aeronautical	20 W 10-28 Vdc	16 #	14" x 12.8" x 4.1" (W x H x D)	$16.5 K
	Wild-Magnavox Wm-101	SPS/4	Surveying / Land	25 W 12 Vdc	32 #	20" x 15.3" x 6.5" (W x H x D)	$69 K
	T-Set MT-2	SPS/2	Navigation / Land, Marine and Aeronautical	130 W	50 #	4800 (volume)	

MANUFACTURER	MODEL	SPS,PPS/ NO. OF CHANNELS	APPLICATION / ENVIRONMENT	POWER	WEIGHT	SIZE	LIST PRICE RECEIVER
Magnavox	T-Set MT-5	SPS/5 (Diff. capability)	Navigation/ Surveying / Land, Marine and Aeronautical	130 W	35 #	4800 (volume)	
	MX-GS-4802 (PLANNED)	SPS/2 (Embedded GPS receiver module)	Navigation / Land, Marine and Aeronautical			5.9" x 4.8" (Min. p.c. size)	
Motorola	Mini-Ranger EAGLE	SPS/4	Navigation/Timing/ Surveying / Land, Marine and Aeronautical	19 W 10-17 or 18-32 Vdc	* 4.5 # ** 2.5#	2.3" x 7.7" x 12.4" (W x H x D)	$18 K
	Mini-Ranger Geodetic System (MRGS)	SPS/4	Surveying/ Navigation / Land, Marine and Aeronautical	< 35 W	< 35 #	2680 (volume)	$33 K
	Mini-Ranger 1400	SPS/4	Navigation / Land, Marine and Aeronautical	50 W 115/230 V 45-66 Hz 20-32 Vdc	50 #	19" x 9" x 18" (W x H x D)	
Norstar Instruments Ltd.	1000 (PLANNED)	SPS/5 or SPS/7	Surveying / Land	69 W 24 Vdc	33 #	17.5" x 2.5" x 12" (W x H x D)	$57 K (SPS/5) $67 K (SPS/7 est.)
	1200 (PLANNED)	SPS/2	Surveying/ Navigation / Land, Marine and Aeronautical	40 W	10 #	600 (volume)	$25 K (est.)
* Receiver ** Ant/Pre							

MANUFACTURER	MODEL	SPS,PPS/ NO. OF CHANNELS	APPLICATION / ENVIRONMENT	POWER	WEIGHT	SIZE	LIST PRICE RECEIVER
Odetics (KODE) Inc.	SatSync III	SPS/1	Timing/Frequency	115 V +/- 10% 60 Hz +/- 10%	25 #	5.25" x 17" x 29" (H x D x W)	
Plessey Avionics, Ltd., U.K.	PA9050 (PA-5) (PLANNED)	PPS/5	Timing Land, Marine, and Aeronautical	40 W 115 Vac 400 Hz 6 - 40 Vdc	9.9 #	3.6" x 7.6" x 9.2" (W x H x D)	
Raytheon Company	JLR-4000	SPS/1	Navigation Land and Marine	------------	----------	5 5/16" x 8 1/4" x 12 1/4" (H x W x D)	$20 K
Rockwell Collins (Military)	AN/VSN-8 M/V (R-M)	PPS/1	Navigation/Timing Military: Land and Marine	14 W 28 Vdc	15.3 #	5" x 10.2" x 13.2" (W x H x D)	$16 K - 25 K
	AV/ASN-149 (V-1) U/H	PPS/2	Navigation/Timing MIL-E 5400 (2) A mil	36 W 115 V 400 Hz	25 #	7.5" x 7.6" x 14.75" (W x H x D)	$30 K - 42 K
	AN/ASN-149 (V2) OH (R-O)	PPS/2	Navigation/Timing MIL-E 5400 (2) A mil	38 W 115 V 400 Hz	25 #	7.5" x 7.6" x 14.75" (W x H x D)	$30K - 38 K
	AN/ASN-149 (V3) C4	PPS/2	Navigation/Timing MIL-E 5400 (2) A mil	36 W 115 V 400 Hz	25 #	7.5" x 7.6" x 14.75" (W x H x D)	$34 K - 42 K
	R-2332/AR 3A (R-A)	PPS/5	Navigation/Timing MIL-E 5400 (2) A mil	73 W	36 #	7.5" x 7.6" x 19.2 " (W x H x D)	$36 K - 50 K
	R-2331/URN 3S (R-S)	PPS/5	Navigation MIL-E 5400 (2) M, A	65 W	50 #	2050 (volume)	$45 K - 60 K

MANUFACTURER	MODEL	SPS,PPS/ NO. OF CHANNELS	APPLICATION / ENVIRONMENT	POWER	WEIGHT	SIZE	LIST PRICE RECEIVER
Rockwell Collins (Military)	Harpoon/Slam R-H/S	PPS/1	Navigation / MIL-E 5400 (2) (A)	35 W 28 Vdc	12.5 #	6.4" x 7.6" x 10.8" (W x H x D)	$25K - 30K
Rockwell Collins (Commercial)	NAVCORE I ® Time	SPS/1	Timing / Land, Marine and Aeronautical	30 W 10 - 40 Vdc	6.5 #	7.4" x 4.8" x 7.7" or 7.4" x 2.4" x 7.7" (2) (W x H x D)	$15 K
	NAVCORE I ® Navigation	SPS/1	Navigation / Land, Marine and Aeronautical	< 30 W 10 - 40 Vdc	6.5 #	7.4" x 4.8" x 7.7" or 7.4" x 2.4" x 7.7" (2) (W x H x D)	$17.5 K
	NAVCORE I ® Poss./Diff.	SPS/1	Surveying/Timing/ Navigation / Land, Marine and Aeronautical	< 30 W 10-40 Vdc	6.5 #	7.4" x 4.8" x 7.7" or 7.4" x 2.4" x 7.7" (2) (W x H x D)	$20 K
	NAVCORE I ® Base Station	SPS/1	Surveying/Timing/ Navigation / Land	550 W 108-125 Vac 60 Hz	225 #	48" x 45" x 29" (W x H x D)	$45 K
Sperry Corporation	GPS Core Module	SPS/1	Navigation / Marine				
Standard Elektrick Lorenz AG (SEL)	GPS L/D (PLANNED)	SPS/4	Navigation / Land and Marine	15 W +12 Vdc -12 Vdc +5 Vdc		90 mm x 130 mm x 60 mm	

MANUFACTURER	MODEL	SPS,PPS/ NO. OF CHANNELS	APPLICATION / ENVIRONMENT	POWER	WEIGHT	SIZE	LIST PRICE RECEIVER
Stanford Telecommunications, Inc. (STI)	5010	SPS/1 or PPS/2	Timing/Navigation / Land	115 Vac +/- 10% 60 Hz 450 W	100 #	12" x 19" (H x W)	
	5403A	PPS/1	Timing / Land	115/230 Vac 47 - 66 Hz 18 - 34 Vdc 74 V A	35 #	3.5" x 19" x 22" (H x W x D)	
	STEL 5300	PPS/2 or PPS/5	Navigation / Land, Marine and Aeronautical	25 - 35 W -5, +5 Vdc 12 - 15 Vdc	3 - 5 #	84 - 130 (volume)	$16.5 K - 35 K
	STEL 5312A	SPS/2 or SPS/5	Navigation/Timing / Land, Marine and Aeronautical	15 - 21 W -5, + 5 Vdc 12 - 15 Vdc	4 #	90 - 135 (volume)	$12 K
	STEL 502B TTS	SPS/1	Surveying/Timing / Land	200 W	< 70 #	3400 (volume)	$17 K
	7200 Satellite Simulator SSS	SPS or PPS /1 to 10	Surveying/Timing/ Navigation (Satellite Simulation) / Land, Marine and Aeronautical	50 - 150 W +PC/AT 115 Vac	50 - 150 # (+PC/AT)	19" x 8.75" x 20" (W x H x D)	$40 K - 260K
Texas Instruments	TI 4100	PPS/4	Surveying/Timing/ Navigation / Land	110 W 28 Vdc	58 #	17.5" x 8.3" x 14.7" (W x H x D)	$120 K (est.)
	TI 420 (PLANNED)	SPS/5	Surveying/Timing/ Navigation / Land	10 W 12 VDC	10 #	6.4" x 8.5" x 4.7" (W x H x D)	
	TI 440	SPS/1 or PPS/1	Navigation / Land, Marine and Aeronautical	85 W 120 W	19 #	467 cu. in.	

MANUFACTURER	MODEL	SPS,PPS/ NO. OF CHANNELS	APPLICATION / ENVIRONMENT	POWER	WEIGHT	SIZE	LIST PRICE RECEIVER
Trimble Navigation	4000 A T-A	SPS/4	Surveying/Timing/ Navigation Land, Marine and Aeronautical	50 W 115/230 Vac 45 - 66 Hz 20 - 35 Vdc	48 #	19" x 7" x 18" (W x H x D)	$28 K
	4000SX T-SX	SPS/5	Surveying Land	60 W 115/230 Vac 45 - 66 Hz 20 - 35 Vdc	49 #	19" x 7" x 18" (W x H x D)	$44 K
	400 T-4	SPS/2	Navigation Land, Marine and Aeronautical	15 W	8.5 #	240 cu. in.	$4 K (in volume)
	10X GPS-Loran C T-X	SPS/2	Navigation Land, Marine and Aeronautical	25 W 12 or 24 Vdc	12 #	4.8" x 10.3" x 11.8" (CDU: 10" x 5" x 3") (W x H x D)	$16 K
	TANS Brick	SPS/2	Navigation/Timing Land, Marine and Aeronautical	3 W	3 #	9.5" x 5" x 2" (W x H x D)	$13 K $4 K (in volume)
	4000 SL T-S	SPS/5	Surveying/Timing Land	35 W	32 #	2100 (volume	$48 K

APPENDIX D

PARTIAL LISTING
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APPENDIX E

GPS GLOSSARY OF TERMS AND ACRONYMS

This appendix has two parts, a glossary of GPS terms and a listing of acronyms. Some of the definitions included in this glossary of GPS terms have been extracted from a paper presented by Dr. David E. Wells, University of New Brunswick, entitled "Recommended GPS Terminology," presented at the First International Symposium on Precise Positioning with the Global Positioning System, Rockville, Maryland, 15-19 April 1985.

The acronyms were extracted from two sources. One source was "Everyman's Guide to Satellite Navigation (A GPS Primer)," which was modified and reprinted by Interstate Electronics Corporation (January 1986) with the permission of ARINC Research Corporation. ARL:UT obtained permission from ARINC to use the list in this volume. The second source, "Acronyms and Abbreviations of Navigation Technical Terms," was prepared by Navigation Technology Seminars, Inc.

2D Accuracy	The two dimensional position acuracy of a position determined by a GPS measurement.
3D Accuracy	The three dimensional position accuracy of a position determined by a GPS measurement.
Almanac	The almanac data or a reduced precision subset of the clock and ephemeris parameters contained in subframe 4 and 5 of the NAV message.
Ambiguity	See carrier beat phase ambiguity.

Anti-Spoofing	The protection of the GPS user segment from simulated signals by unauthorized sources.
Bandwidth	A measure of the width of the spectrum of a signal (frequency domain representation of a signal) expressed in Hertz (Stiffler, 1966).
Baseline	A baseline consists of a pair of stations for which *simultaneous* GPS data have been collected.
Beat Frequency	Either of the two additional frequencies obtained when signals of two frequencies are mixed, equal to the sum or difference of the original frequencies, respectively. For example, in the identity, cos A cos B = (cos(A+B) + cos(A-B))/2, the original signals are A and B and the beat signals are A+B and A-B. The term Carrier Beat Phase refers only to the difference A-B, where A is the incoming Doppler-shifted satellite carrier signal, and B is the nominally-constant reference frequency generated in the receiver.

Between-Epoch Difference	The difference between two complete carrier beat phase measurements made by the same receiver on the same signal (same satellite, same frequency), but at different time epochs.
Between-Frequency Difference	The instantaneous difference between the complete carrier beat phase measurements made by the same receiver observing signals from the same satellite at two (or more) different frequencies.
Between-Receiver Difference	The instantaneous difference in the complete carrier beat phase measurement made at two receivers simultaneously observing the same received signal (same satellite, same frequency).
Between-Satellite Difference	The instantaneous difference in the complete carrier beat phase measurement made by the same receiver observing two satellite signals simultaneous (same frequency).

Binary Biphase Modulations	Phase changes on a constant frequency carrier of either 0 degrees or 180 degrees (to represent binary 0 or 1 respectively). These can be modelled by: $y = A(t) \cos (wt - o)$ where the amplitude function $A(t)$ is a sequence of +1 and -1 values (to represent 0 degrees and 180 degrees phase changes, respectively) (Dixon, 1975).
C/A-code	See S-code.
Carrier	A radio wave having at least one characteristic (e.g., frequency, amplitude, phase) which may be varied from a known reference value by modulation (Bowditch, 1981, Vol. II).
Carrier Beat Phase	The phase of the signal which remains when the incoming Doppler-shifted satellite carrier signal is beat (the difference frequency signal is generated) with the nominally-constant reference frequency generated in the receiver.

Carrier Beat Phase Ambiguity	The uncertainty in the initial measurement, which biases all measurements in an unbroken sequence. The ambiguity consists of three components
Carrier Frequency	The frequency of the unmodulated fundamental output of a radio transmitter (Bowditch, 1981, Vol. II).
Channel	A channel of a GPS receiver consists of the radiofrequency and digital hardware, and the *software, required to track the signal* from one GPS satellite at one of the two GPS carrier frequencies.
Chip	The minimum time interval of either a zero or a one in a binary pulse code.

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Clock Offset	The difference between a clock and GPS time.
Code Phase	A fractional part of a code chip usually expressed as a number between 0-1.
Complete Instantaneous Phase Measurement	A measurement of carrier beat phase which includes the integer number of cycles of carrier beat phase since the initial phase measurement. See fractional instantaneous phase measurements.
Correlation-Type Channel	A GPS receiver channel which uses a delay lock loop to maintain an alignment (correlation peak) between the replica of the GPS code generated in the receiver, and the incoming code.

Delay Lock	The technique whereby the received code (generated by the satellite clock) is compared with the internal code (generated by the receiver clock) and the latter shifted in time until the two codes match. Delay lock loops can be implemented in several ways, for example, tau dither and early-minus-late gating (Spilker, 1980).
Delta Pseudorange	The difference between two carrier beat phase measurements, made coincidentally with (code) pseudorange epochs.
Differenced Measurements	*See* Between-Epoch Difference; Between-Frequency Difference; Between-Receiver Difference; Between-Satellite Difference. Many combinations of differences are possible. Which differences, and their order, should be specified in describing a processing method (for example Receiver-Satellite Double Differences).
Differential GPS	The use of a single frequency GPS receiver remote to a fixed site receiver with the transfer of signal corrections from the fixed site to the remote site.

Differential Positioning	See Relative Positioning.
Dilution of Precision (DOP)	A description of the purely geometrical contribution to the uncertainty in a dynamic position fix, given by the expression DOP=TRACE(ATA)-1, where A is the design matrix for the solution (dependent on satellite/receiver geometry). The DOP factor depends on the parameters of the position fix solution. See GDOP, PDOP, HDOP, VDOP, TDOP, and HTDOP.
Doppler Shift	The apparent change in frequency of a received signal due to the rate of change of the range between the transmitter and receiver. See carrier beat phase.
Dynamic Positioning	See Kinematic Positioning.

Ephemerides	Plural of ephemeris.
Ephemeris	A set of parameters used to determine the position and velocity of a satellite as a *function of time.*
Fast Switching Channel	A switching channel with a sequence time short enough to recover (through software prediction) the integer part of carrier beat phase.
Fractional Instantaneous Phase Measurement	A measurement of the carrier beat phase which does not include any integer cycle count. It is a value between zero and one cycle. See complete instantaneous phase measurement.

GPS GLOSSARY OF TERMS

Frequency Band	A range of frequencies in a particular region of the electromagnetic spectrum (Wells, 1974).
Frequency Spectrum	The distribution of amplitudes as a function of frequency of the constituent waves in a signal (Wells, 1974).
GDOP	Geometrical DOP (three position coordinates plus clock offset in the solution).
Global Positioning System	The constellation of GPS satellites and fixed ground stations designed for realtime navigation and geodetic positioning.

GPS Time	The average broadcast time of the operational satellites.
GPS Time Steer Schedule	The scheduled adjustment of the clocks on board each satellite.
GPS-UTC Phase and Frequency Offset	The offset at a given epoch between GPS and UTC.
Handover Word	The word in the GPS message that contains time synchronization information for the transfer from the s-code to the P-code (Milliken and Zoller, 1980).

HDOP	Horizontal DOP (two horizontal coordinates).
HTDOP	Horizontal-time DOP (two horizontal coordinates and clock offset).
Independent Baselines	Baselines determined from independent observing sessions.
Independent Observing Sessions	Sessions for which any common biases affecting the observations can be ignored.

Integrated Doppler	The accumulated phase change of a satellite signal at a receiver between t1 and t2.
Interferometry	See *Relative Positioning*.
Ionospheric Delay	The signal delay between the satellie and a receiver caused by effects of the ionosphere.
Ionospheric Refraction	A signal traveling through the ionosphere (which is a nonhomogeneous and dispersive medium) experiences a propagation time different from that which would occur in a vacuum. Phase advance depends on electron content and affects carrier signals. Group delay depends on dispersion in the ionosphere as well, and affects signal modulation (codes). The phase and group advance are of the same magnitude but opposite sign (Davidson et al., 1983).

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Kalman Filter	A *sequential* process for estimation of model parameters in the presence of stochastic noise.
Kinematic (or Dynamic) Positioning	Refers to applications in which a trajectory (of a ship, ice field, tectonic plate, etc.) is determined.
L-Band	The radio frequency band extending from 390 MHz to (nominally) 1550 MHz (Bowditch, 1981, Vol. II).
L1 Signal	1575.42 MHz suppressed carrier signal from GPS satellites that contain C/A and P-Code and a navigation message.

L2 Signal	1227.6 MHz suppressed carrier signal from GPS satellites that contain P-Code and a navigation message.
Lane	The area (or volume) enclosed by adjacent lines (or surfaces) of zero phase of either the carrier beat phase signal, or of the difference between two carrier beat phase signals. On the earth's surface a line of zero phase is the locus of all points for which the observed value would have an exact integer value for the complete instantaneous phase measurement. In three dimensions, this locus becomes a surface.
Measured Range	Pseudorange minus the estimate of the ground clock bias.
Multichannel Receiver	A receiver containing many channels.

Multipath Error	An error resulting from interference between radiowaves which have travelled between the transmitter and the receiver by two paths of different electrical lengths (Bowditch, 1981, Vol. II).
Multiplexing Channel	A receiver channel which is sequenced through a number of satellite signals (each from a specific satellite and at a specific frequency) at a rate which is synchronous with the satellite message bit-rate (50 bits per second, or 20 milliseconds per bit). Thus one complete sequence is completed in a multiple of 20 milliseconds.
Navigation Message	The system data, D(t), includes SV ephemerides, system time, SV clock behavior data, status messages, and C/A to P (or Y) code handover information, etc.
Observing Session	The period of time over which GPS data are collected simultaneously by two or more receivers.

Outage	The occurrence in time and space of a GPS Dilution of Precision value exceeding a specified maximum.
P-Code	The Precise (or Protected) GPS code--a very long (about 1014 bit) sequence of pseudorandom binary biphase modulations on the GPS carrier at a chip rate of 10.23 MHz which does not repeat itself for about 267 days. Each one-week segment of the P-code is unique to one GPS satellite, and is reset each week.
PDOP	*Position DOP (three coordinates).*
Phase Lock	The technique whereby the phase of an oscillator signal is made to become a smoothed replica of the phase of a reference signal by first comparing the phases of the two signals and then using the resulting phase difference signal to adjust the reference oscillator frequency to eliminate phase difference when the two signals are next compared (Bowditch, 1981, Vol. II). The smoothing time span occurs over approximately the inverse of the bandwidth. Thus a 40 Hz loop bandwidth implies an approximately 25 millisecond smoothing time constant.

Phase Observable	See carrier beat phase.
Point Positioning	The determination of absolute position of a single point, as opposed to relative positioning (which see).
Precise Positioning Service (PPS)	The highest level of dynamic positioning accuracy that will be provided by GPS, based on the dual frequency P-code (U.S. DoD/DOT, 1982).
PRN Number	The number assigned to the pseudorandum noise (PRN) code transmitted from each satellite.

GPS GLOSSARY OF TERMS

Propagation Delay	The delay in reception of a signal at a point due to the media between the two points. This includes time of flight in a vacuum and ionospheric and tropospheric delays.
Pseudolite	The ground-based differential GPS station which transmits a signal with a structure similar to that of an actual GPS satellite (Kalafus, 1984).
Pseudorandom Noise (PRN) Code	Any of a group of binary sequences that exhibit noise-like properties, the most important of which is that the sequence has a maximum autocorrelation, at zero lag (Dixon, 1975).
Pseudorandom Noise Code (PRN Code)	Any of a group of binary sequences that exhibit noise-like properties, the most important of which is that the sequence has a maximum autocorrelation at zero lag.

Pseudorange	The time shift required to align (correlate) a replica of the GPS code generated in the receiver with the incoming GPS code, scaled into distance by the speed of light. This time shift is the difference between the time of signal reception (measured in the receiver time frame) and the time of emission (measured in the satellite time frame).
Pseudorange Difference	See carrier beat phase.
Range Change	Change of the distance between a satellite and the observer.
Range Rate	The rate of change of the distance between the satellite and the observer due to satellite motion.

Receiver Channel	See channel.
Reconstructed Carrier Phase	See *carrier* beat phase.
Relative Positioning	The determination of *relative* positions between two or more receivers which are simultaneously tracking the same radiopositioning signals (e.g., from GPS).
Restart Capability	The property of a sequential processing computer program, that data can be processed rigorously in a sequence of computer runs, rather than only in one long run.

S-Code	The Standard GPS code (formerly the C/A, Coarse/Acquisition, or Clear/Access code) -- a sequence of 1023 pseudorandom binary biphase modulations on the GPS carrier at a chip rate of 1.023 MHz, thus having a code repetition period of one millisecond.
Satellite Configuration	The state of the satellite constellation at a specific time, relative to a specific user or set of users.
Satellite Constellation	The arrangement in space of the complete set of satellites of a system like GPS.
Selective Availability	The denial of undegraded accuracy of the GPS system to unauthorized users.

Signal-to-Noise Ratio	The ratio of signal strength to background noise, in units of voltage, power, decibels, etc.
Simultaneous Measurements	Measurements referred to time frame epochs which are either exactly equal, or else so closely spaced in time that the time misalignment can be accommodated by correction terms in the observation equation, rather than by parameter estimation.
Slow Switching Channel	A switching channel with a sequencing period which is too long to allow recovery of the integer part of the carrier beat phase.
Spread Spectrum Systems	A system in which the transmitted signal is spread over a frequency band much wider than the minimum bandwidth needed to transmit the information being sent (Dixon, 1975).

Squaring-Type Channel	A GPS receiver channel which multiplies the received signal by itself to obtain a second harmonic of the carrier, which does not contain the code modulation.
Standard Positioning Service (SPS)	The level of kinematic positioning accuracy that will be provided by GPS based on the single frequency S-code (U.S. DoD/DOT, 1982)
Static Positioning	Positioning applications in which the positions of points are determined, without regard for any trajectory they may or may not have.
SV Health	The operational status of a given satellite.

SV Orbit Adjust	The controlled movement of a satellite to change the orbit of the satellite.
SV Upload Schedule	The schedule for transfer of updated information into satellite memory.
Switching Channel	A receiver channel which is sequenced through a number of satellite signals (each from a specific satellite and at a specific frequency) at a rate which is slower than, and asynchronous with, the message data rate.
TDOP	Time DOP (clock offset only).

GPS GLOSSARY OF TERMS

Telemetry	The transfer of monitor data from the satellite to a ground station.
Time Transfer	The transfer of time between two or more clocks using GPS signals.
TRANSIT	The Navy Navigation Satellite System using the Doppler technique to determine position.
Translocation	See Relative Positioning.

Tropospheric Delay	Signal delay between a satellite and a receiver caused by tropospheric effects.
Universal Coordinated Time (UTC)	The internationally agreed time scale for broadcast signals, often called Greenwich Mean Time.
User Equivalent Range Error (UERE)	The contribution to the range measurement error from an individual error source, converted into range units, assuming that error source is uncorrelated with all other error sources (Martin, 1980).
User Range Accuracy	User range accuracy (URA) is a statistical indicator of the contribution of the apparent clock and ephemeris prediction accuracies to the ranging accuracies obtainable with a specific SV based on historical data.

User Time Bias	The difference between GPS time and receiver time
VDOP	Vertical DOP (height only).
Z-Count Word	The GPS satellite clock time at the leading edge of the next data subframe of the transmitted GPS message (usually expressed as an integer number of 1.5 second periods((van Dierendock et al., 1980).

GPS AND NAVIGATION ACRONYMS

ACRONYM	DEFINITION
2DRMS	2 times the standard Deviation (Root Mean Square); 2 dimensional case
A-S	Anti-Spoofing
A/C	Aircraft
ACU	Antenna Control Unit
ADF	Automatic Direction Finder
ADI	Attitude Direction Indicator
AEEC	Airlines Electronic Engineering Committee
AFB	Air Force Base
AFGL	Air Force Geophysics Lab (Hanscom AFB)
AFLC	Air Force Logistics Command
AFSC	Air Force Systems Command
AFSCF	Air Force Satellite Control Facility
AGD	Australian Geodetic Datum
AGL	Above Ground Level
AODC	Age of Data, Clock
AODE	Age of Data, Ephemeris
ARINC	Aeronautical Radio, Inc. (establishes avionics standards)
ARTCC	Air Route Traffic Control Center (FAA facility)
ASAT	Anti-satellite
ATE	Automatic Test Equipment
AVIM	Aviation Intermediate Maintenance
AVUM	Aviation Unit Maintenance
BIT	Built-in Test
BP SK	Bi-Phase Shift Key
BPS	Bits per second
C/A	Coarse/Acquisition GPS signal. Available to civil users.
CDMA	Code Division Multiple Access
CDU	Control Display Unit
CEP	Circular Error Probable
CGIC	Civil GPS Information Center
CGS	Civil GPS Service
CGS-ICD	Interface Control Document between Civil GPS Service and Military OPSCAP
CNS	Communications, Navigation, and Surveillance
Comm.	Communications
CONUS	Continental United States
CRPA	Controlled Radiation (Reception) Pattern Antenna
Cs	Cesium (Beam Atomic Standard Clock)
CSOC	Consolidated Space Operations Center (at Falcon AFB)
CUT	Coordinated Universal Time
CV	Crypto-Variable
D to A	Digital to Analog
DARPA	Defense Advanced Research Projects Agency (Washington, D.C.)
DGPS	Differential GPS
DL	Data Link
DMA	U.S. Defense Mapping Agency
DME	Distance Measuring Equipment
DN	Day Number
DOC	U.S. Department of Commerce

GPS AND NAVIGATION ACRONYMS

ACRONYM	DEFINITION
DoD	U.S. Department of Defense
DOP	Dilution of Precision
DOT	U.S. Department of Transportation
DS	Direct Support
DSARC	Defense Systems Acquisition Review Council
DT&E	Development Test and Evaluation
ECEF	Earth-Centered, Earth-Fixed
ED	European Datum
EIRP	Effective Instantaneous Radiated Power
EMC	Electromagnetic Capability
EMI	Electromagnetic Interference
EMP	Electromagnetic Pulse
EOL	End of Life
EW	Electronic Warfare
F3	Form, Fit, and Function
FAA	U.S. Federal Aviation Administration (Part of DOT)
FANS	Future Air Navigation Systems Committee
FCC	U.S. Federal Communications Commission
FCC	Fire Control Computer (JPO version)
FDMA	Frequency Division Multiple Access
FMI	Flexible Modular Interface
FOC	Full Operational Capability
FOM, FM	Figure of Merit
FRP	Federal Radionavigation Plan
FRPA	Fixed Radiation Pattern Antenna
FSED	Full Scale Engineering Development
FY	Fiscal Year
GA	Ground Antenna
GDM	General Development Model
GDOP	Geometric Dilution of Precision
GMT	Greenwich Mean Time
GPS	Global Positioning System
GS	General Support
HD	High Dynamic
HDOP	Horizontal Dilution of Precision
HDUE	High Dynamic User Equipment
HELO	Helicopter
HOW	Hand Over Word
HSI	Horizontal Situation Indicator
HUD	Head Up Display
ICAO	International Civil Aviation Organization
ICC	Interface Control Contractor
ICD	Interface Control Document
ICD-GPS	Interface Control Document, issued by Joint Program Office
ID	Identification
IFRB	International Frequency Review Board
ILS	Instrument Landing System
ILTS	Intermediate Level Test Set

GPS AND NAVIGATION ACRONYMS

ACRONYM	DEFINITION
IMO	International Maritime Organization
IMU	Inertial Measurement Unit
INS	Inertial Navigation System
IOC	Initial Operational Capability
ION	Institute of Navigation
IOT&E	Initial Operational Test and Evaluation
IR	Infra-Red
ITU	International Telecommunications Union
J/S	Jamming/Signal (Ratio)
JCS	Joint Chiefs of Staff
JPO	Joint Program Office for GPS (at El Segundo, CA)
JSSMO	Joint Services Support Management Organization
L-Band	L-Band Frequency (about 1-2 GHz)
LD	Low Dynamic
LORAN	Long Range Navigation System
LRU	Line Replaceable Unit
LSB	Least Significant Bit
M max CT	Maximum Corrective Maintenance Time
M mean CT	Mean Corrective Maintenance Time
MARAD	Maritime Administration
MCS	GPS Master Control Station (at Colorado Springs, CO)
MD	Medium Dynamic
MGRS	Military Grid Reference System
MLS	Microwave Landing System
MLV	Medium Launch Vehicle (e.g., Delta II)
MMD	Mean Mission Duration
MP	Manpack
MPS	Meters per Second
MS	Monitor Station
MSB	Most Significant Bit
MSL	Mean Sea Level
MSS	Mobile Satellite Service
MTBF	Mean Time Between Failures
MTBM	Mean Time Between Maintenance
MVUE	Man/Vehicular User Equipment
NAD-27	North American Datum, 1927
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NAV	Navigation
NBS	National Bureau of Standards
NDB	Non-Directional Beacon
NHTSA	National Highway Traffic Safety Administration
nm	nautical miles
NOTAMS	Notice to Airmen
NSA	National Security Administration
nsec	nanosecond
NTDS	Naval Tactical Data System
OBCP	On-Board Computer Program

GPS AND NAVIGATION ACRONYMS

ACRONYM	DEFINITION
OCS	Operational Control Segment (Master Control Station)
OdBI	0 Decibels (Unity Gain) - The radiation pattern gain of an Isotropic antenna.
OMB	Office of Management and Budget
OPS	Operations
OPSCAP	Operational Status and Capability Reporting System
ORMS	OPSCAP Reporting and Management System
OSD	Office of the Secretary of Defense
P	Precise
P-channel	Precision code channel
P-code	Precision code - provided for military and certain other users.
PDOP	Position Dilution of Precision
PL	Pseudolite
PLL	Phase Lock Loop
PPS	Precise Positioning Service (GPS) (see P-code)
PRN, PN	Pseudo Random Noise, Pseudo Noise
PSE	Peculiar Support Equipment
PSK	Phase Shift Keying
RAJPO	Range Applications Joint Program Office
Rb	Rubidium (Gas Atomic Standard Clock)
RDSS	Radiodetermination Satellite Service
REAC	Reaction Time
RF	Radio Frequency
RFI	Radio Frequency Interference
RMS	Root Mean Square
RNAV	Area Navigation
RNPC	Required Navigation Performance Capability
RPU	Receiver Processing Unit
RPV	Remotely Piloted Vehicle
RSPA	Research and Special Programs Administration of DOT
RSS	Root Sum Squared
RTCA	Radio Technical Commission for Aeronautics
RTCM	Radio Technical Commission for Maritime Services
S-band	Microwave frequency band, about 2-4 GHz
SA	Selective Availability
SAC	Strategic Air Command
SC-155	RTCA Special Committee on future CNS for aviation
SC-159	RTCA Special Committee to set minimum aviation system performance standards for GPS
SEP	Spherical Error Precision
SGLS	Space-Ground Link, S-Band
sigma	Standard Deviation
SPS	Standard Positioning Service (GPS)
SS	Space Segment
SS	Submarine
STANAG	Standardization Agreement (NATO)
STOL	Short Take-off and Landing
STS	Space Transportation System (space shuttle)
SUNS	Small Unit Navigation System
SV	Space Vehicle

GPS AND NAVIGATION ACRONYMS

ACRONYM	DEFINITION
TAC	Tactical Air Command
TACAN	Tactical Air Navigation System
TBD	To Be Determined
TBS	To Be Supplied
TD	Tokyo Datum
TDMA	Time Division Multiple Access
TDOP	Time Dilution of Precision
TEMP	Test and Evaluation Master Plan
TLM	Telemetry
TOW	Time of Week
TSPI	Time, Space, Position Information
TT&C	Tracking, Telemetry, and Control
TTFF	Time to First Fix
TTSF	Time to Subsequent Fix
UE	User Equipment
UERE	User Equivalent Range Error
UMTA	Urban Mass Transit Administration
URA	User Range Accuracy
URE	User Range Error
US	User Segment
USNO	U.S. Naval Observatory
UTC	Universal Time Coordinated
VAFB	Vandenburg Air Force Base
VDOP	Vertical Dilution of Precision
VHF	Very High Frequency
VLBI	Very Long Baseline Interferometry
VLF	Very Low Frequency
VOR	VHF Omni-Range Navigation System
VPA	Vehicle Power Adapter
VTOL	Vertical Takeoff and Landing
W.R.T.	With respect to
WARC	World Administrative Radio Conference
WDOP	Weighted Dilution of Precision
WGS	World Geodetic System (1984 and 72)
WN	Week Number
YPG	Yuma Proving Ground

8 March 1988

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